
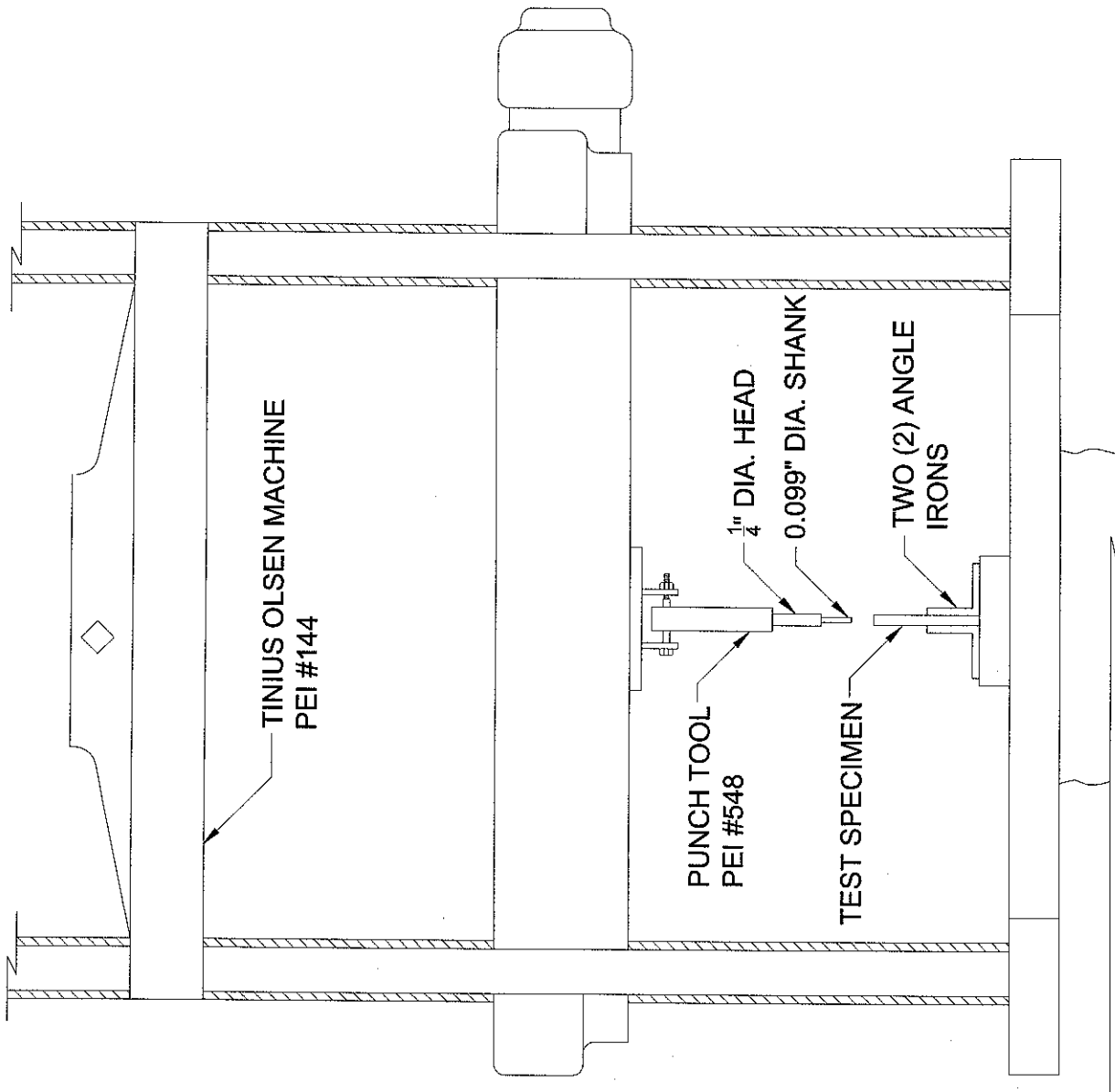



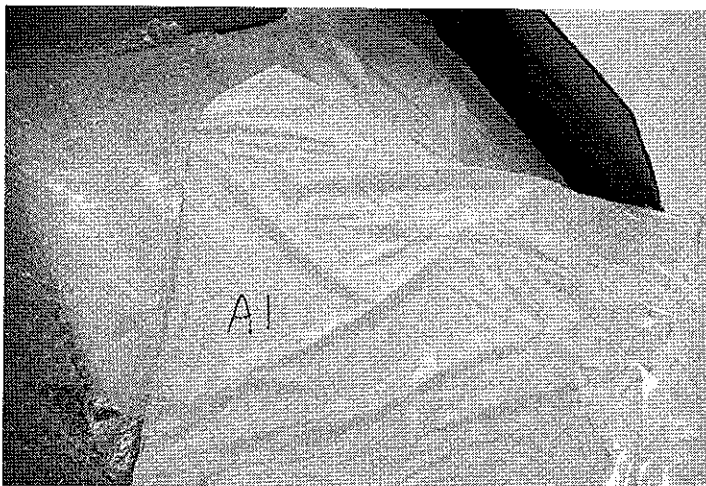
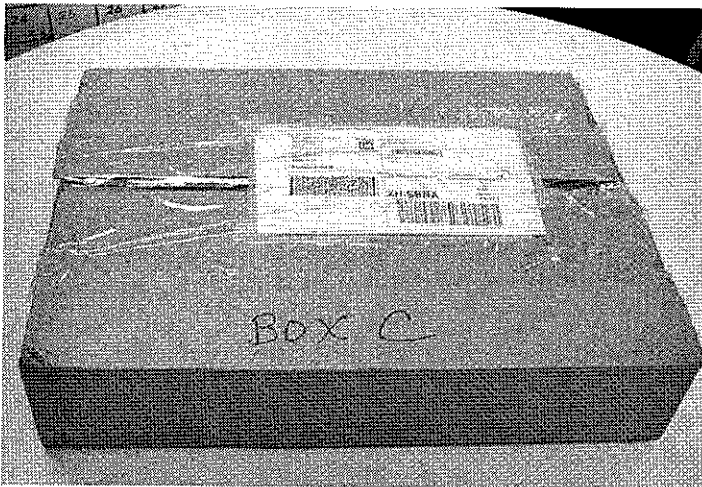
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DATE: 6/15/05	SCALE:	 Progressive Engineering Inc. 58840 State Road 15 Goshen, IN 46528 Phone (574) 633-0337 Fax (574) 633-0736 www.p-e-i.com	
DRAWING NUMBER F971			
TITLE: TEST SET-UP			



DWN. BY: A. BENDER DATE: 6/15/05 SCALE: DRAWING NUMBER: F1216		This drawing and all information contained herein is the property of PROGRESSIVE ENGINEERING, INC. and is not to be reproduced without the written permission of P.E.I. P.E.I. assumes no responsibility for unauthorized use of this drawing.		TITLE: TEST SET-UP	
		 Progressive Engineering Inc. 58640 State Road 15 Goshen, IN 46528 Phone (574) 533-0337 Fax (574) 533-9736 www.p-e-i.com			

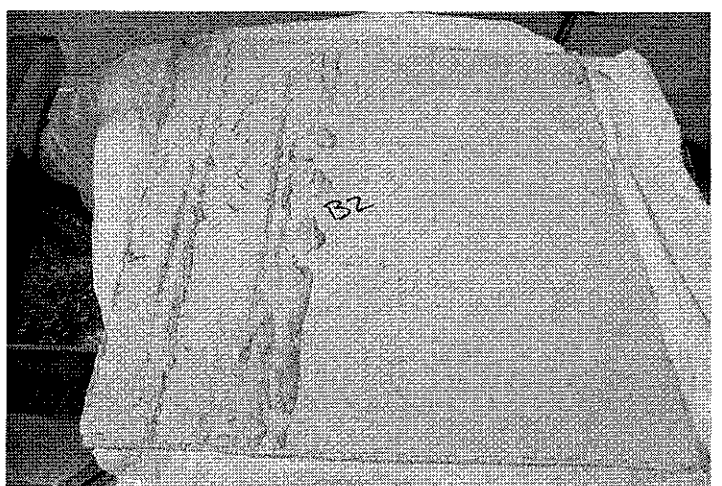
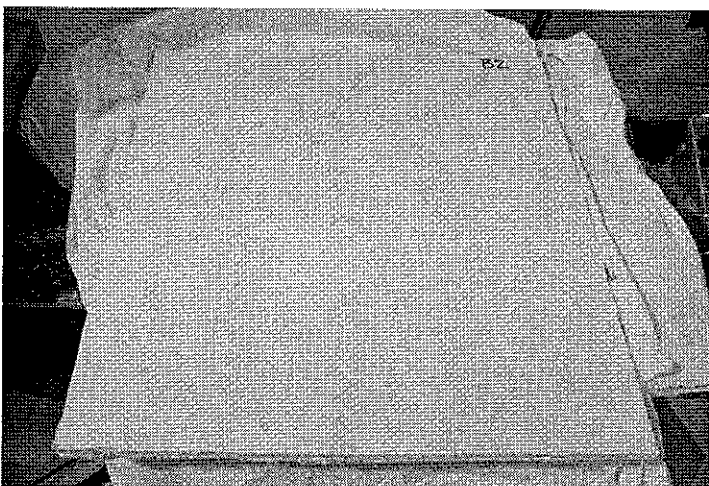
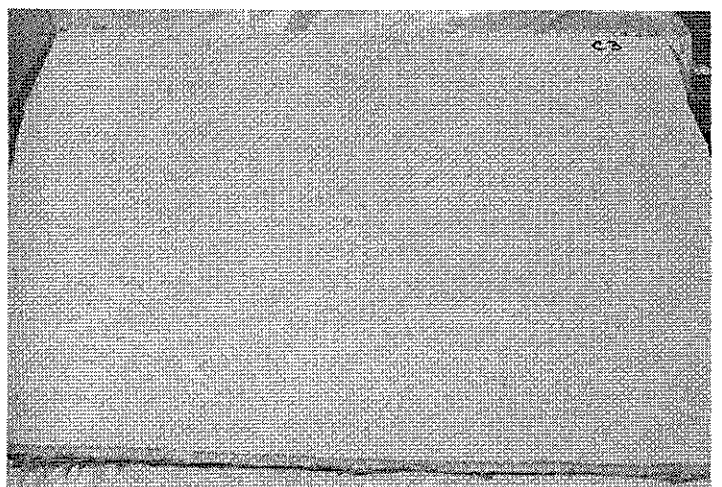
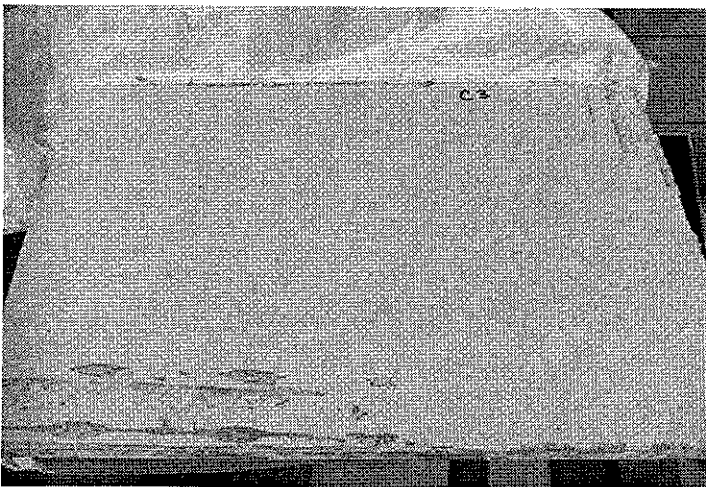
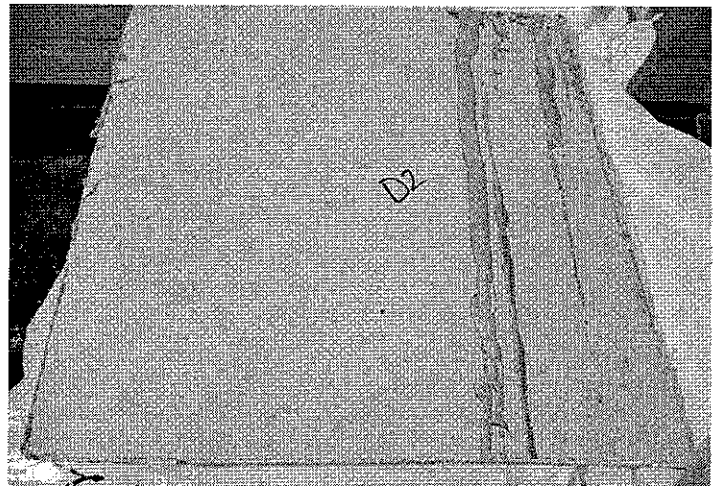
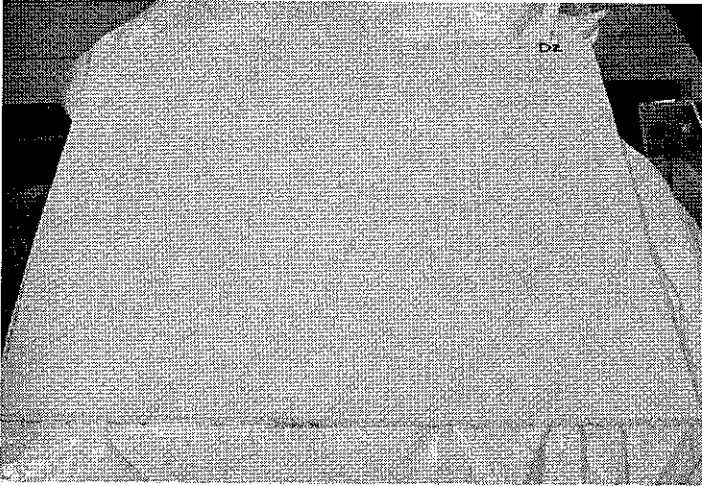
Progressive Engineering Inc.

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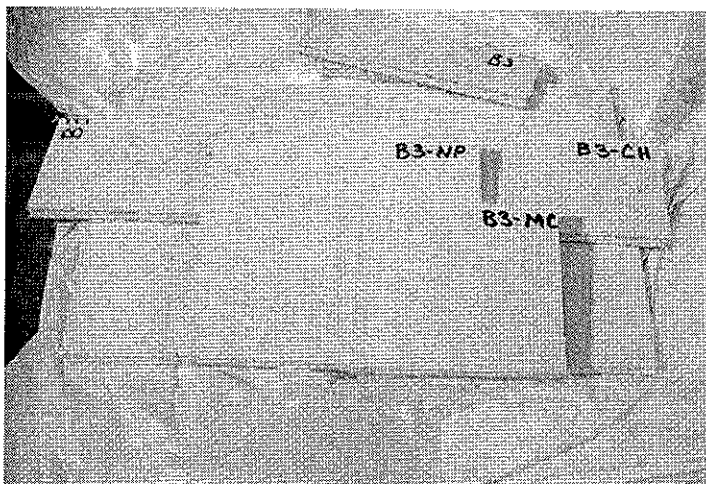
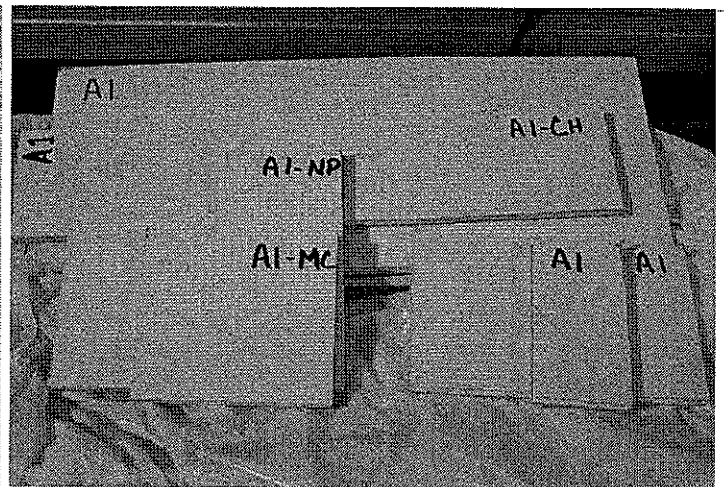
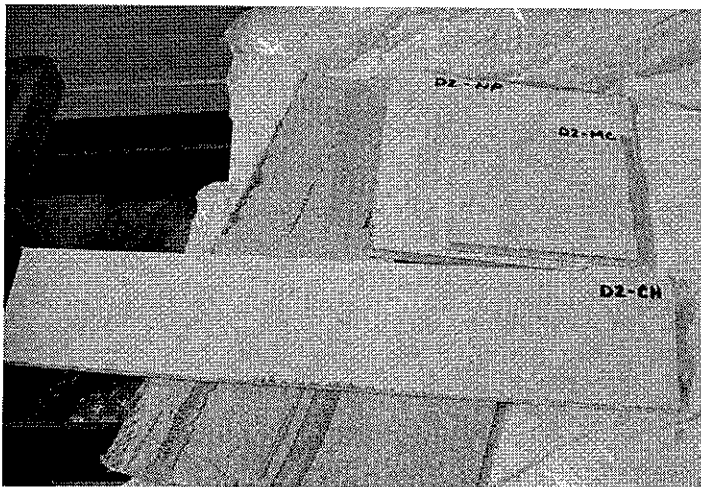
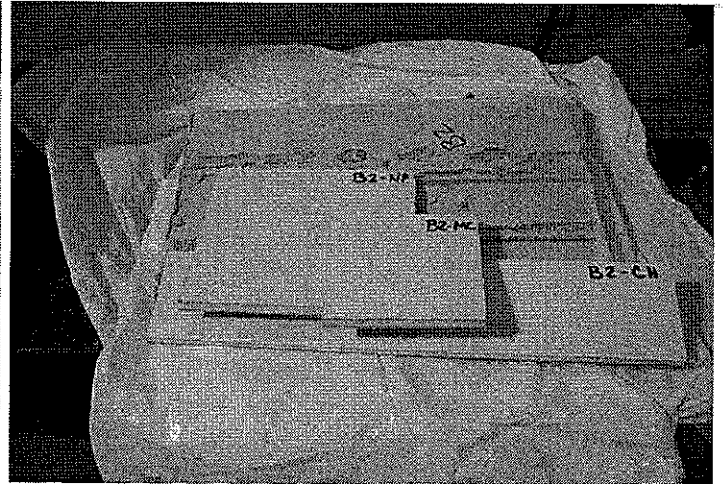
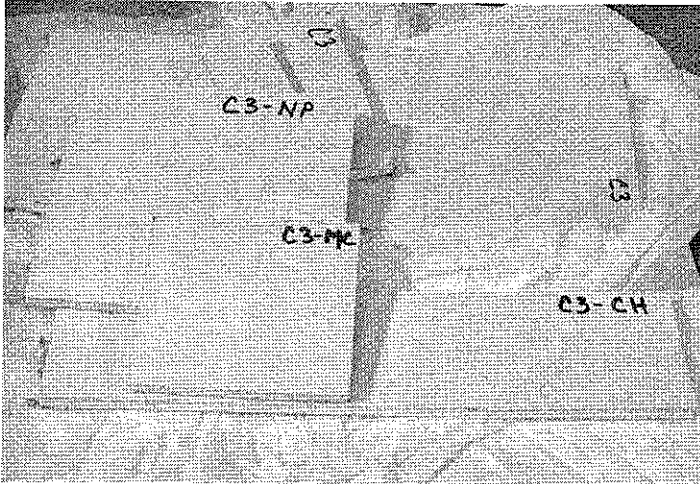
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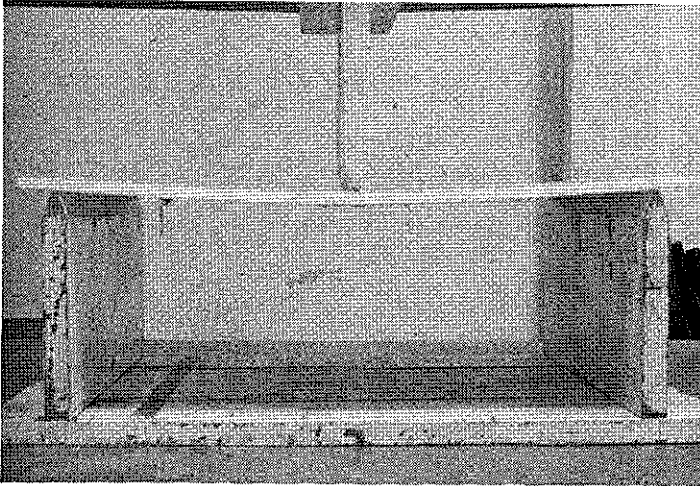
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MOISTURE CONTENT / NAIL PULL / CORE HARDNESS SAMPLES

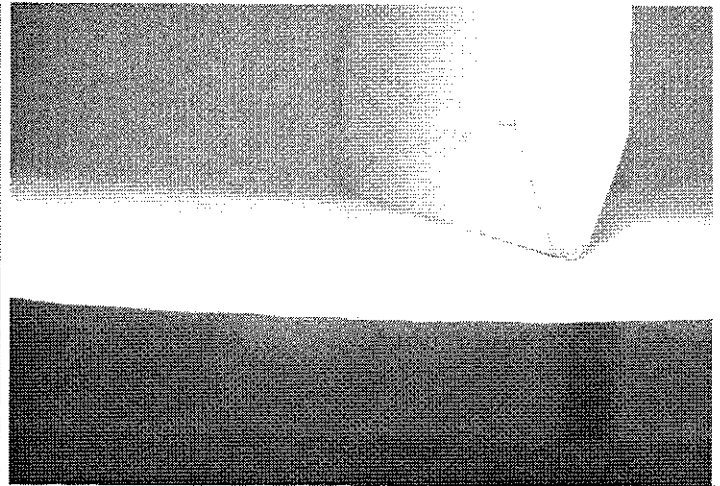


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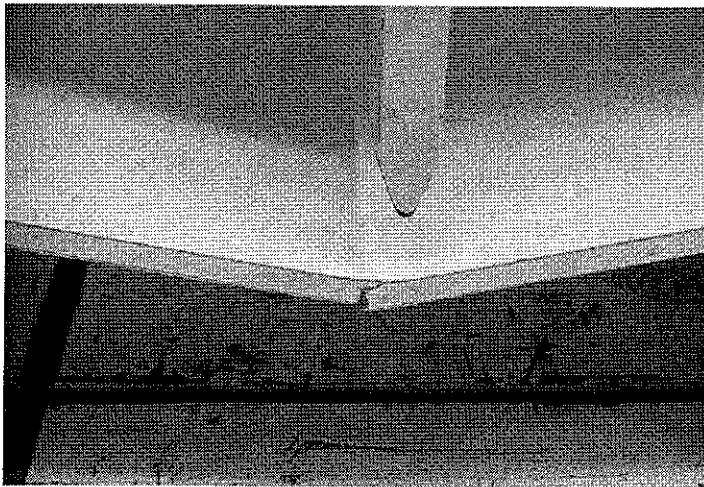
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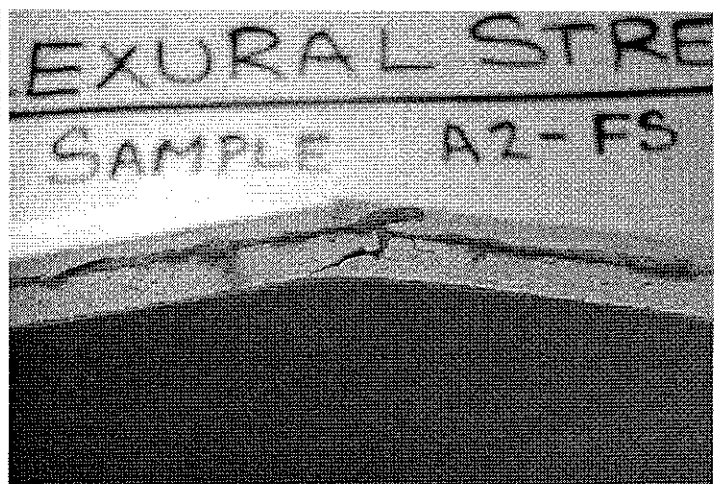
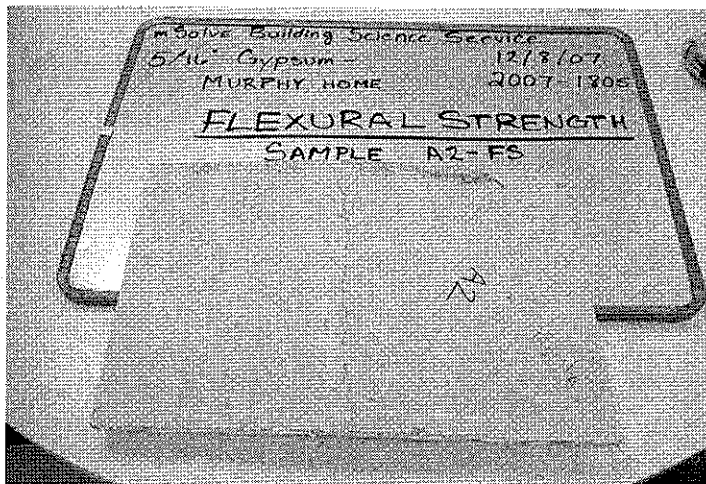
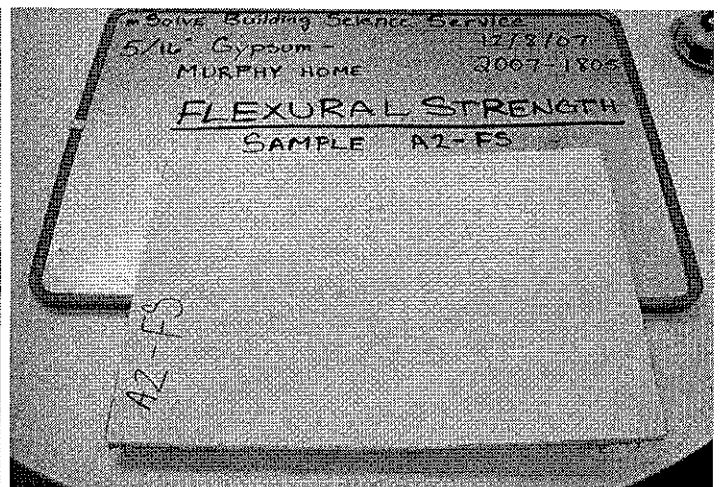
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Test Setup

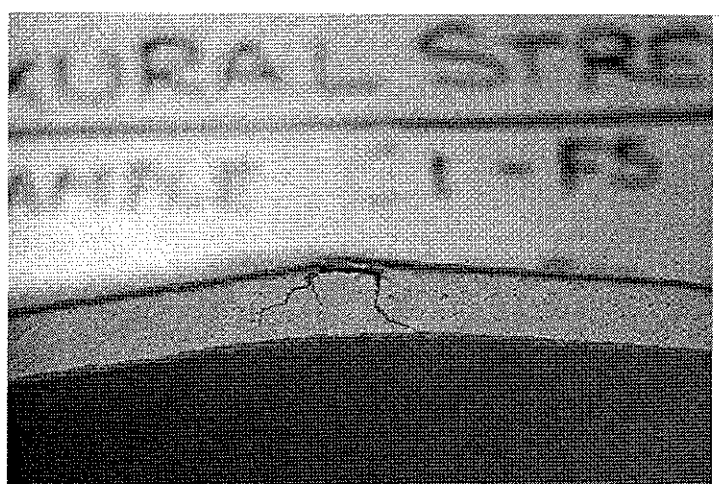
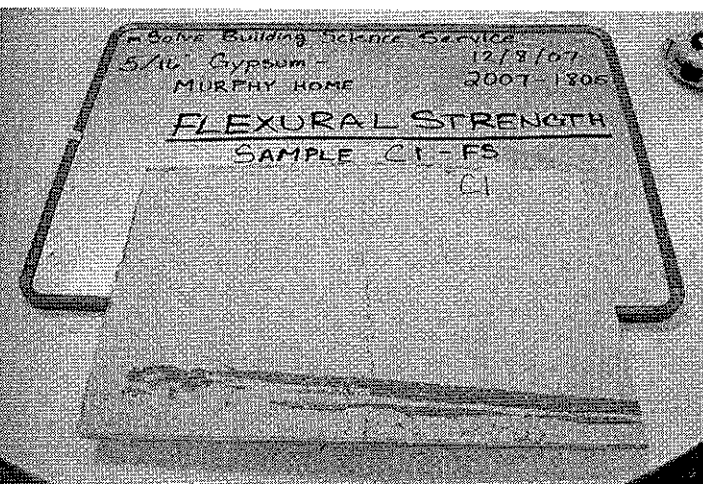
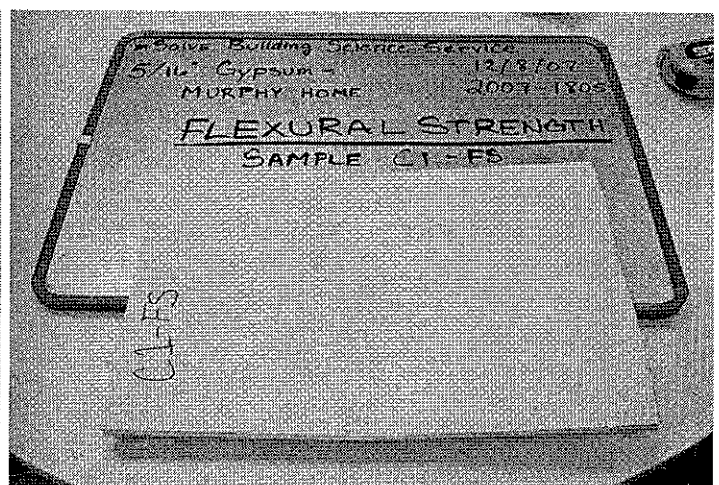
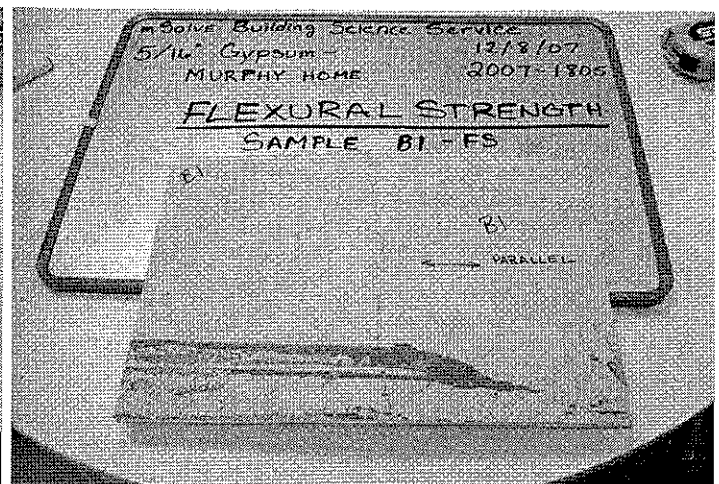
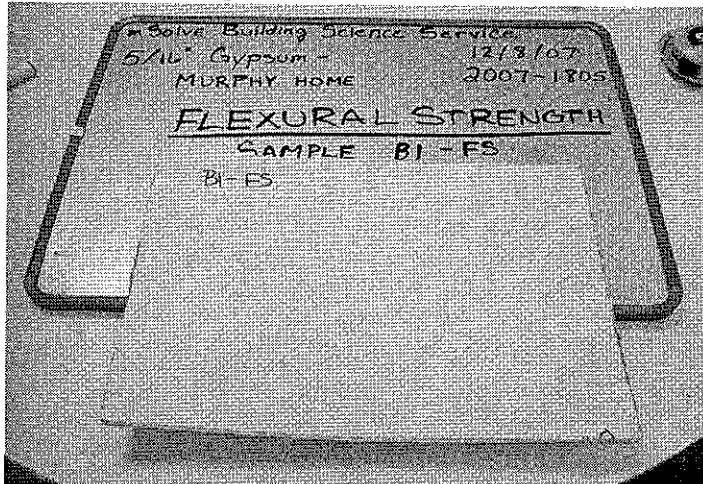


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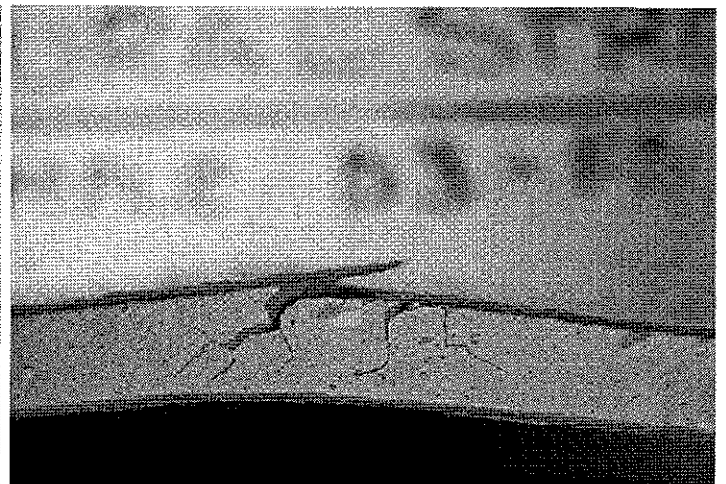
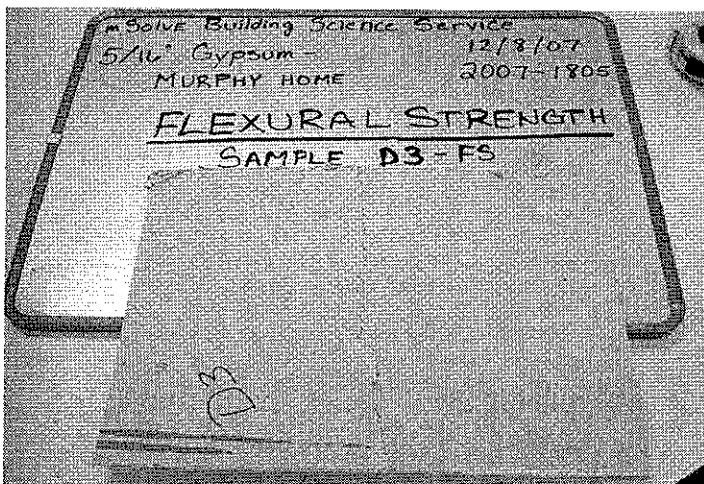
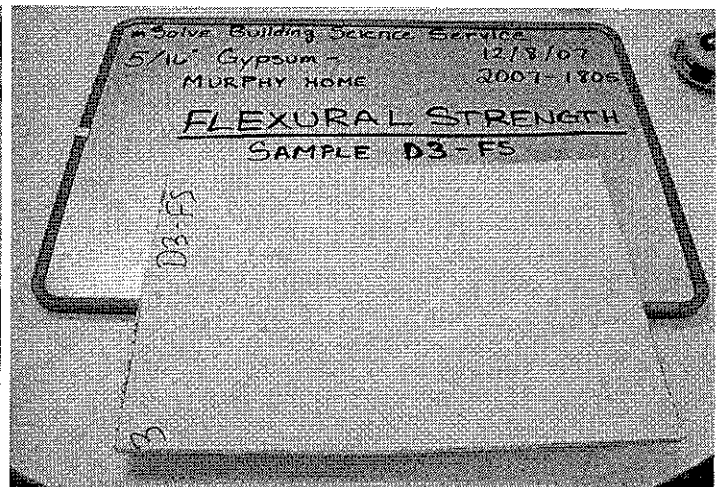
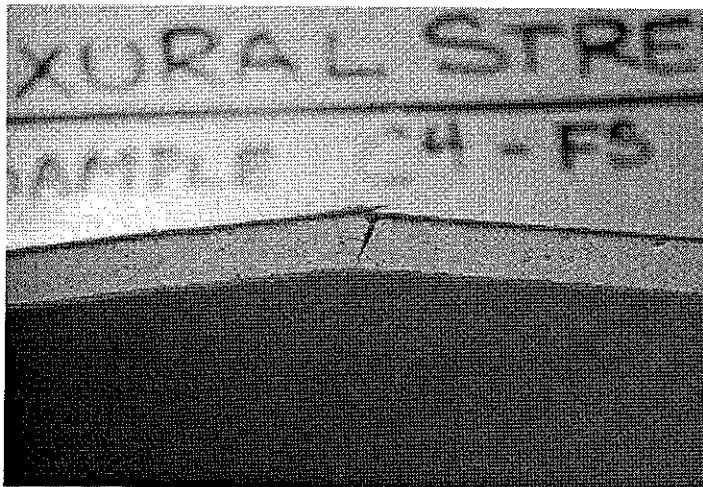
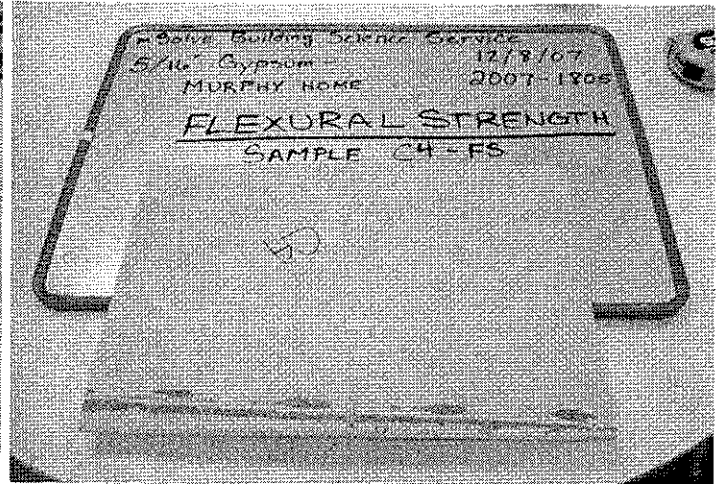
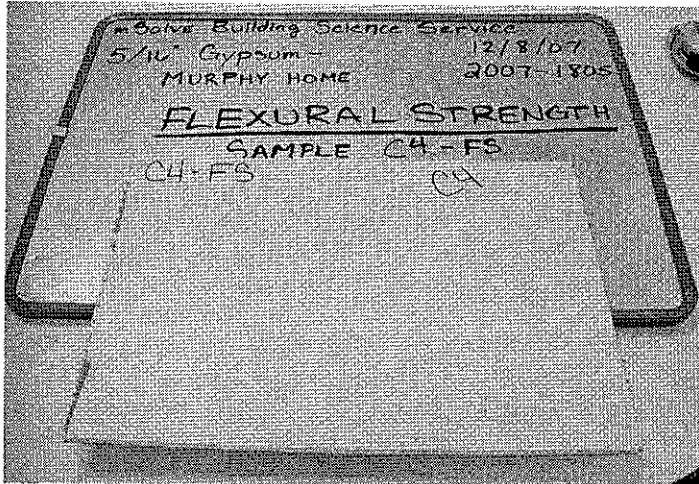
Progressive Engineering Inc.

Flexural Strength Test



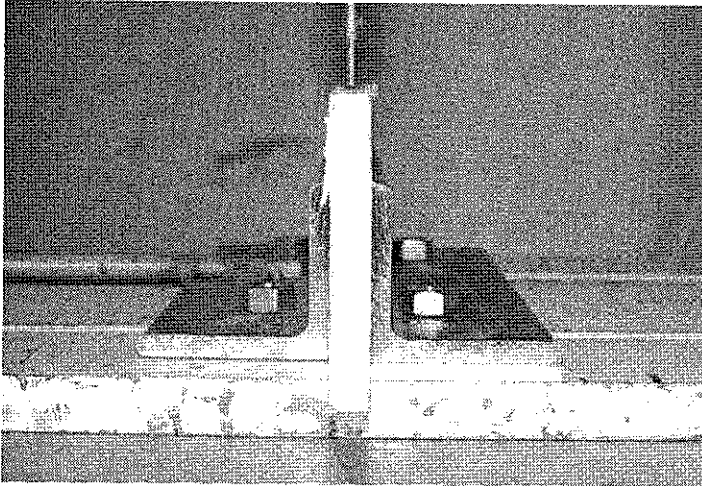
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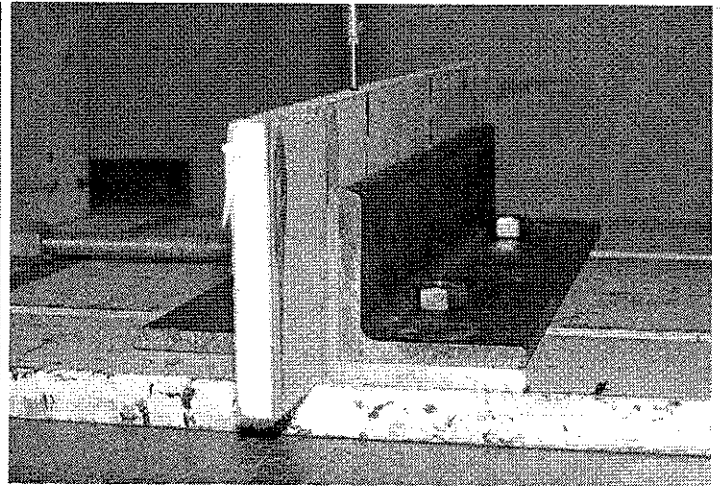


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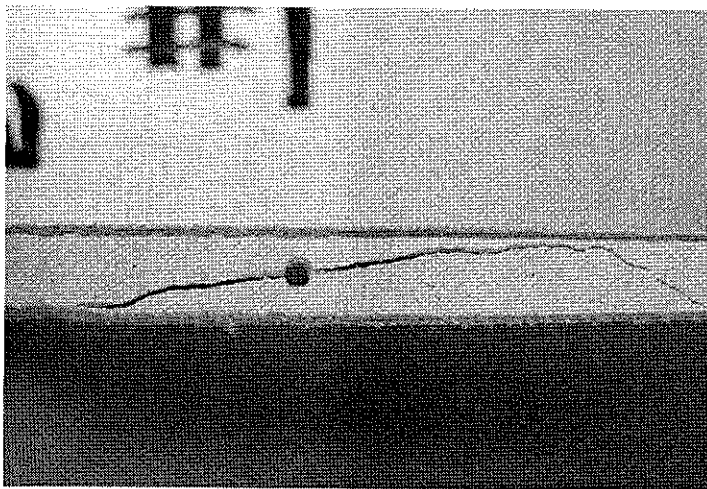
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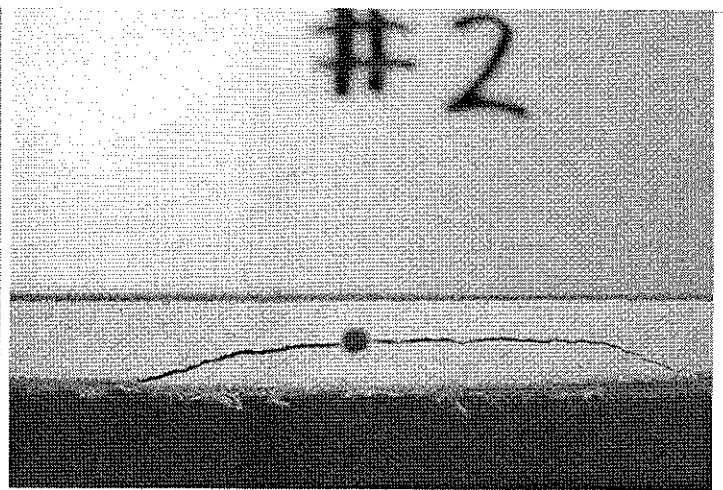
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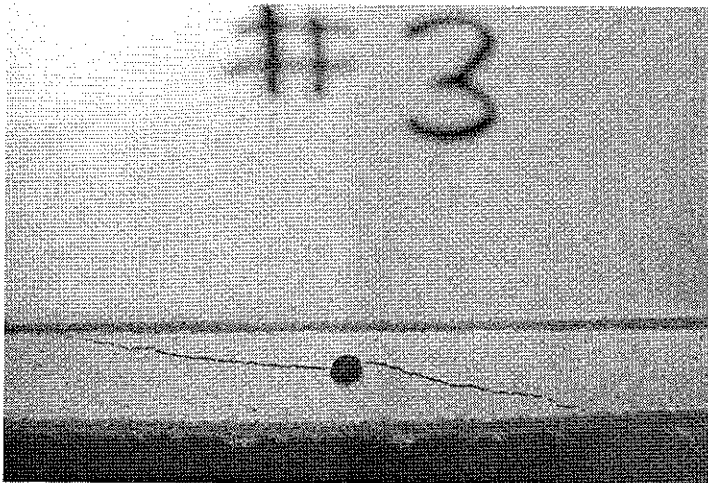
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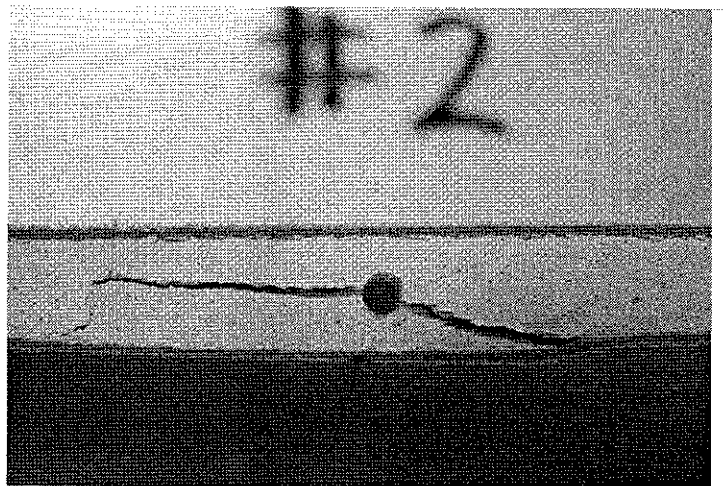
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Typical Failure



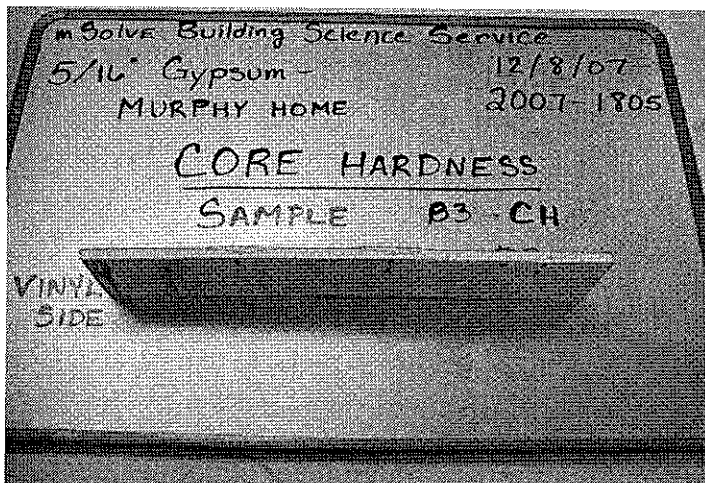
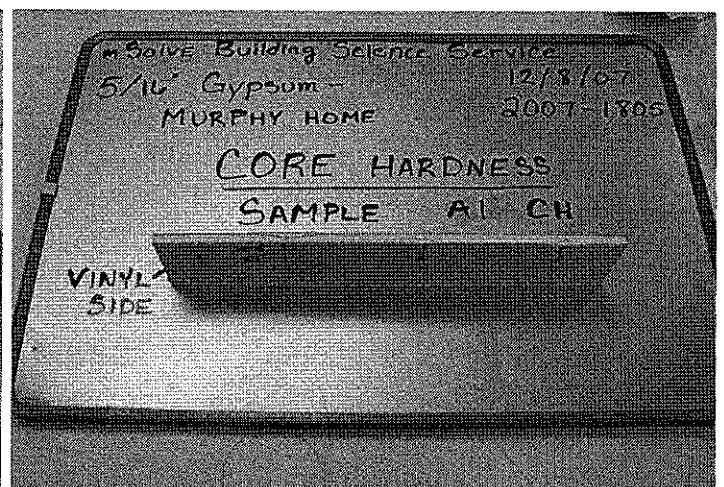
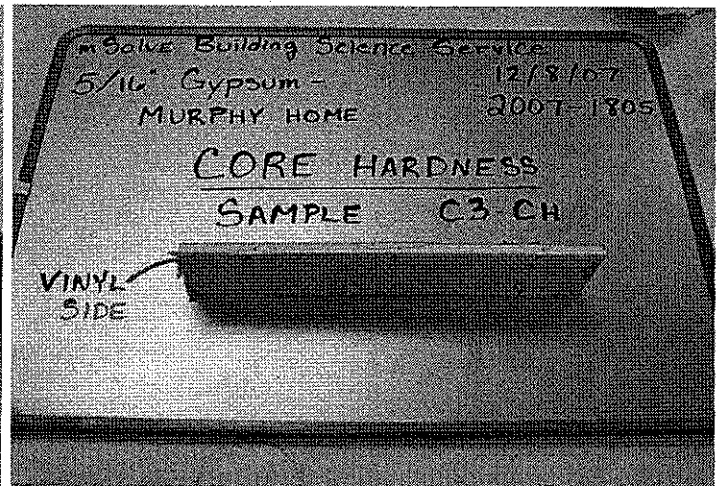
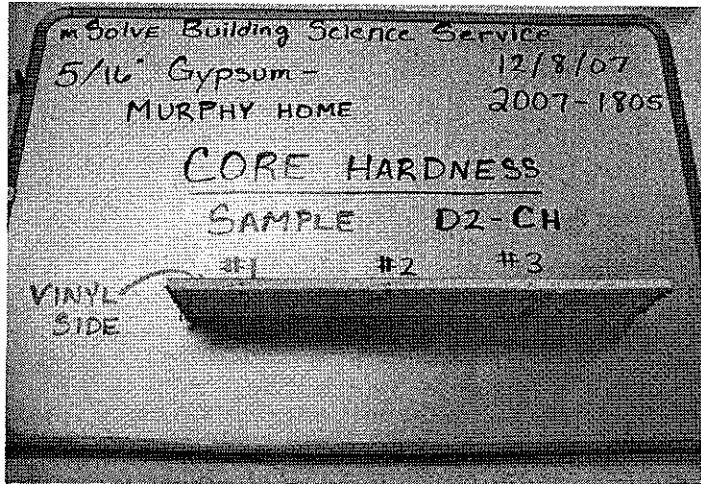
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Typical Failure

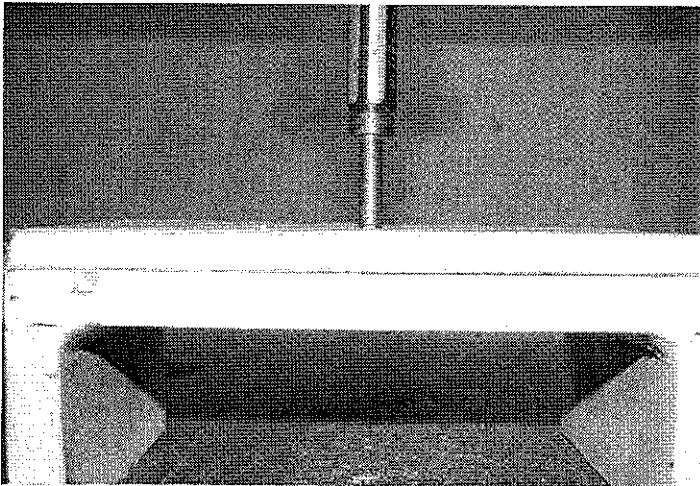
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Core Hardness Test

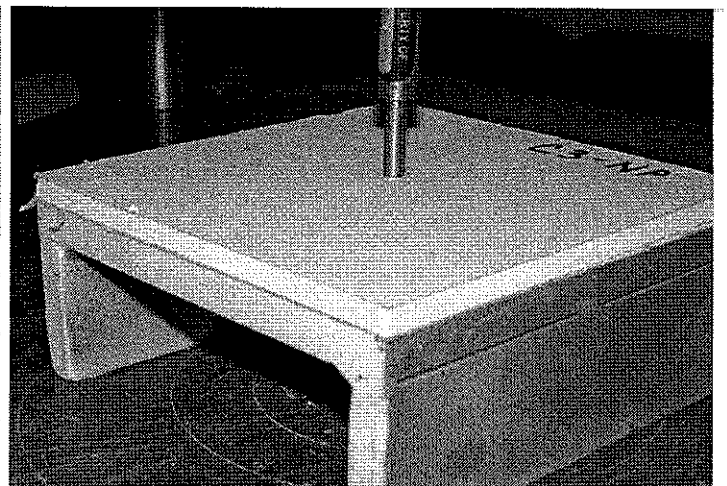


Progressive Engineering Inc.

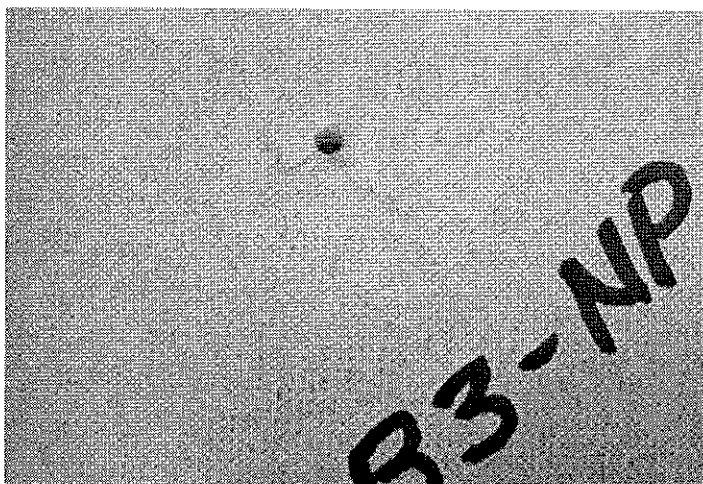
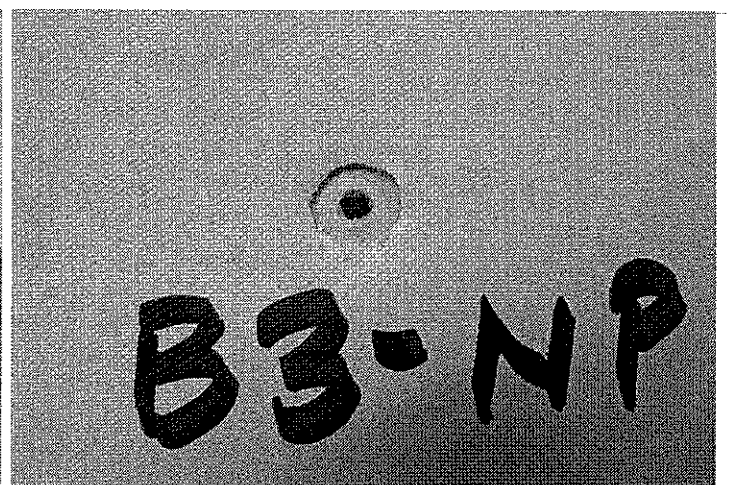
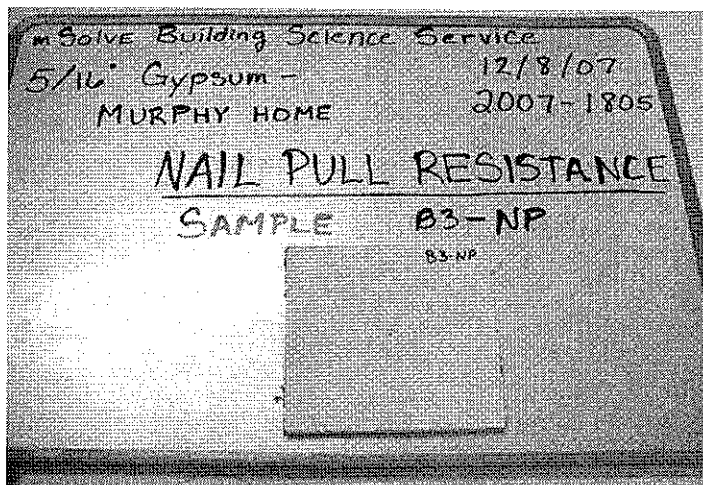
Nail Pull Test



Test Setup

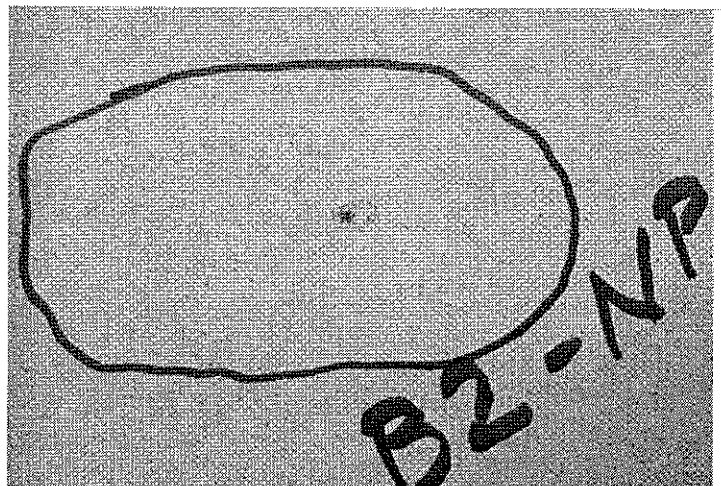
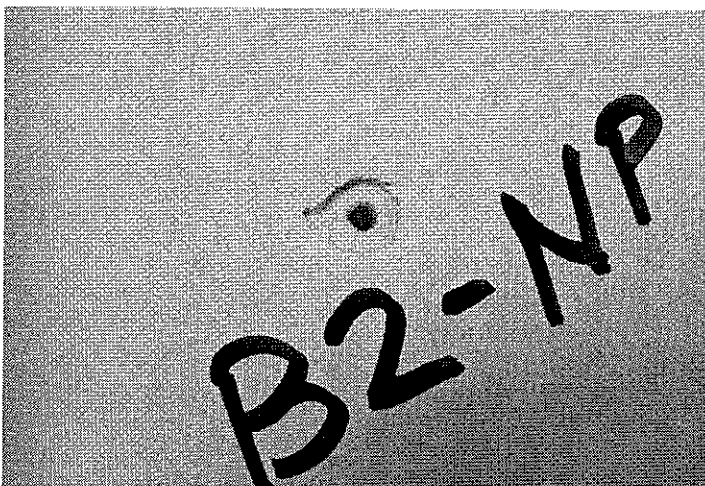
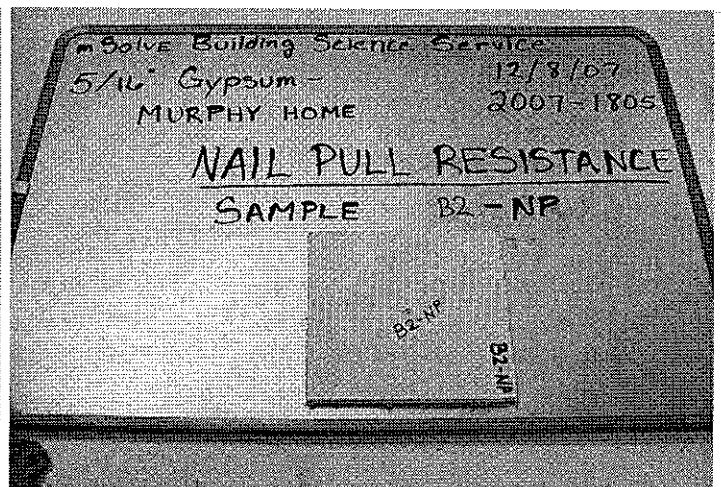
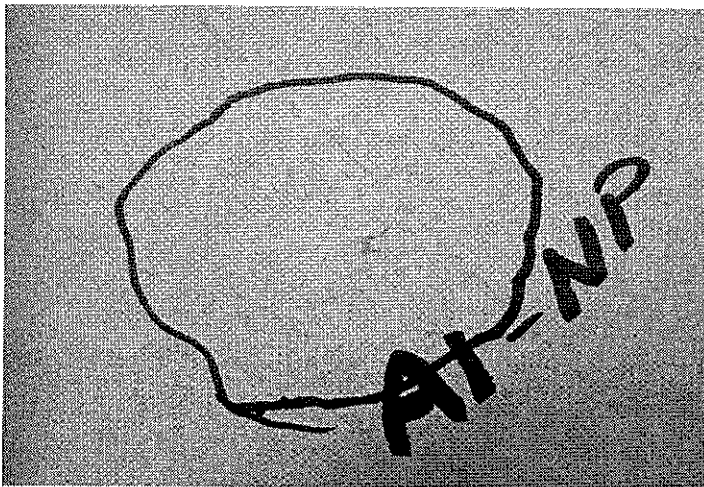
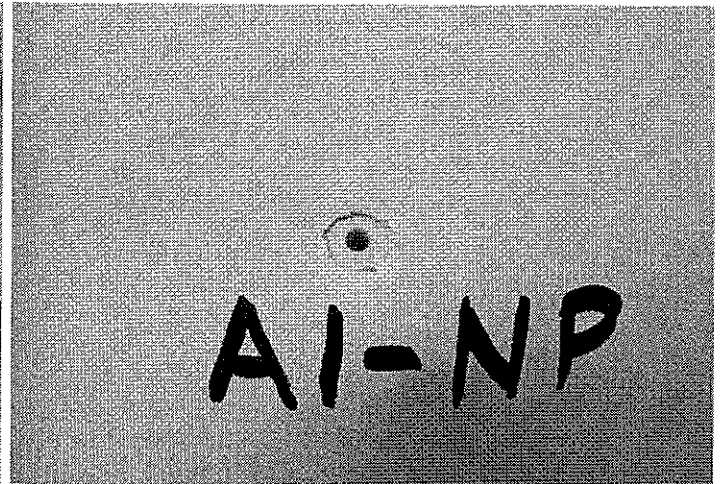
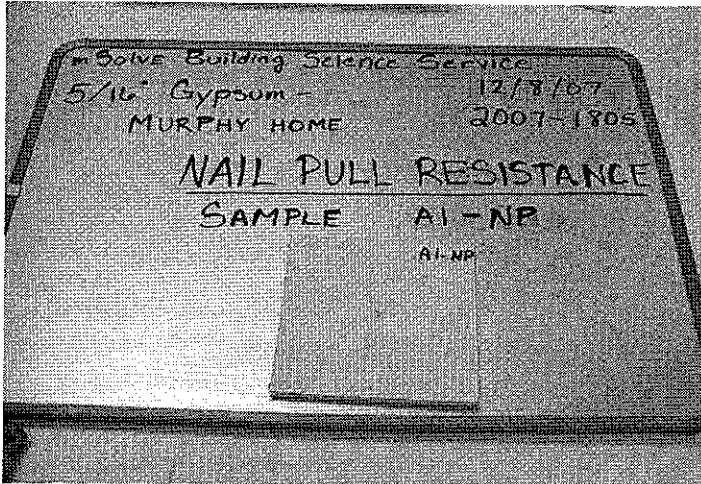


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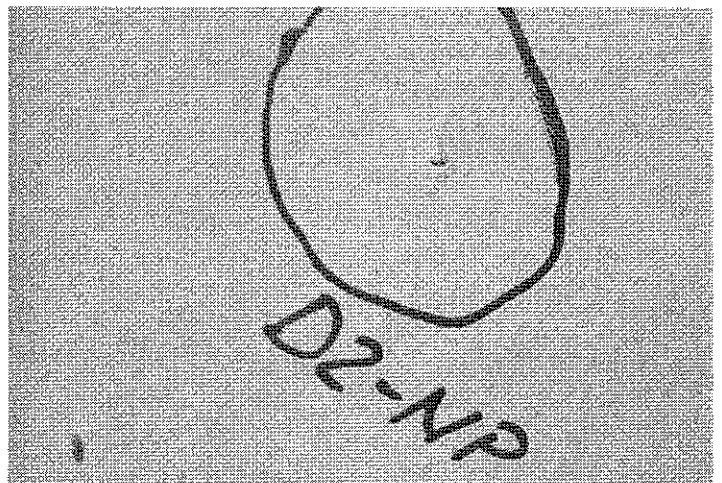
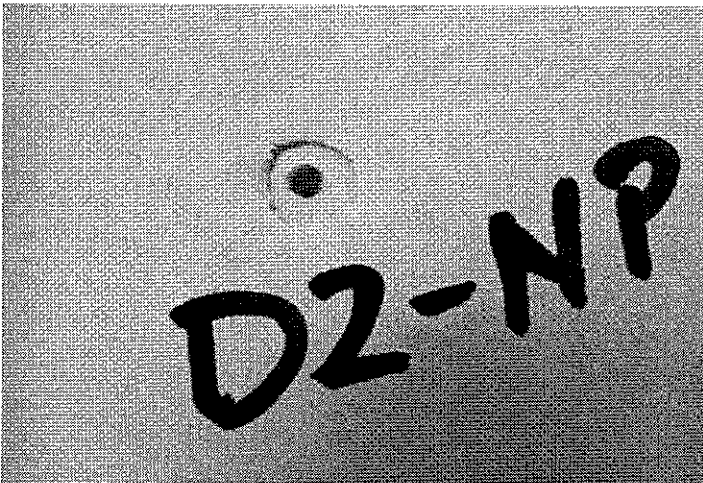
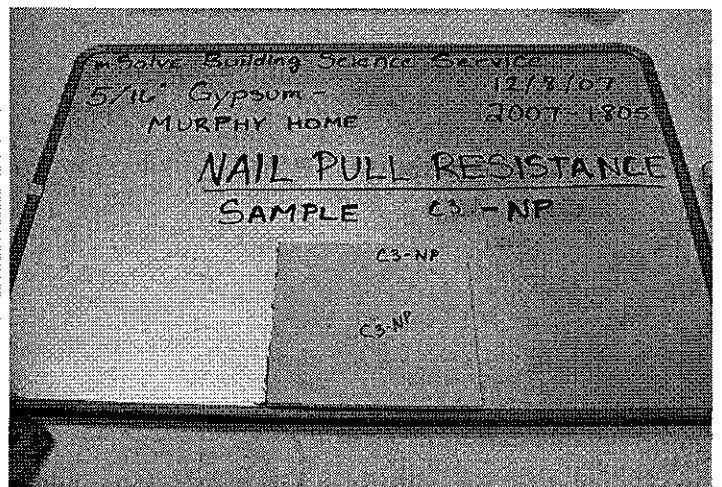
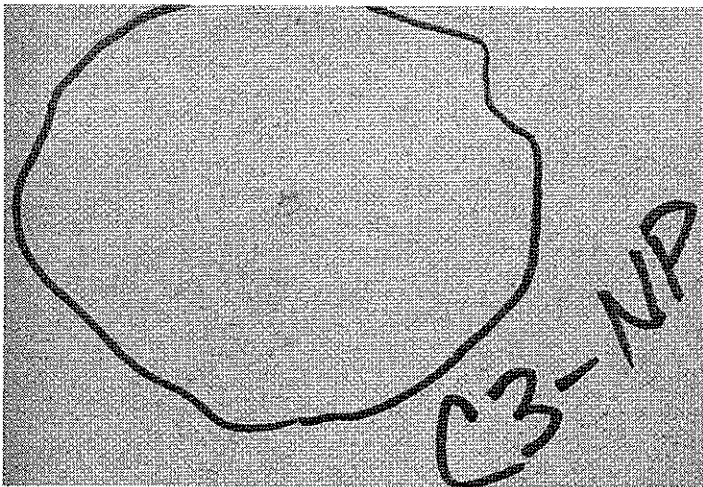
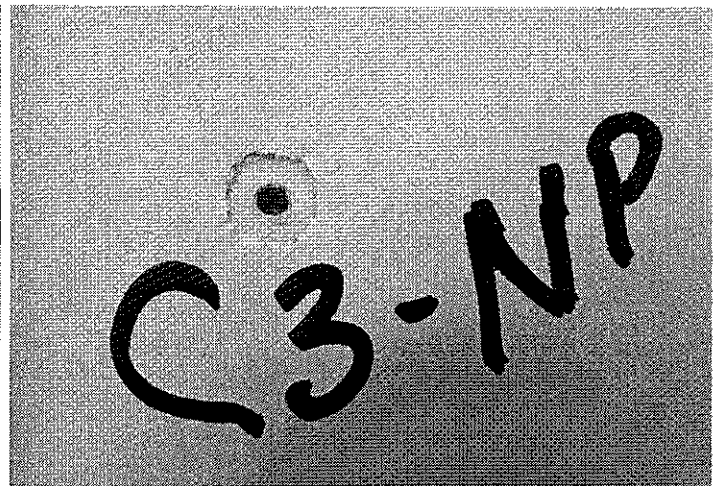
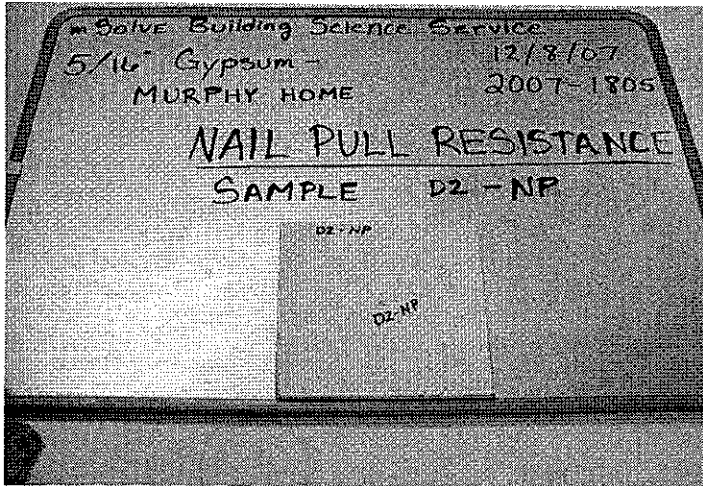
Progressive Engineering Inc.

Nail Pull Test



Progressive Engineering Inc.

Nail Pull Test





**TESTING
LISTING
EVALUATION**

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FAX: 574-773-2260

**NTA 07-11
COMPARISON TESTING OF HAND HELD MOISTURE METERS (HHMM)
WHEN USED ON 5/16-IN VINYL COVERED GYPSUM;
DELMHORST BD2100 PIN TYPE HHMM
AND DELMHORST ACCUSCAN SURFACE TYPE HHMM**

Prepared for:
**Ritchey and Simpson, PLLC
3288 Morgan Drive, Suite 100
Birmingham, Alabama 35216-3084**

Phone: (205)876-1600
Fax: (205)876-1616
Web: www.RitcheySimpson.com

Test Report: 120707-26
Issued: December 11, 2007

Prepared By:
Dale Arter
Testing Director

Reviewed By:
Douglas Berger, P.E.
Test Engineer



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SE120707-26

Prepared By: Dale Arter
Reviewed & Approved By: Douglas Berger

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Form QA 4.3
Issued/Revised: 12/11/07



1. INTRODUCTION

1.1. GENERAL

Moisture content of gypsum panels is dependant on various construction and environmental conditions. Measuring the moisture content in the field is usually performed using a Hand Held Moisture Meter (HHMM) which fall into the categories of conductance meters or dielectric meters. As stated in ASTM D4444⁴ Sections 3 and 4, these meters take electrical measurements, which are influenced by actual moisture content and a number of material variables, and compare them to calibration tables to produce a moisture content reading. The maximum accuracy can only be obtained by an awareness of the effect of each parameter on the meter output. Also, it should be noted that According to the owner's manual, the dielectric meter uses a reference scale when used on non-wood products. The numbers on this scale are relative or qualitative indications of moisture levels, not percent moisture content.

1.2. OBJECTIVE AND SCOPE

Ritchey and Simpson, PLLC retained NTA Testing Laboratories, Inc. to evaluate various types of HHMMs when used on vinyl covered 5/16-in gypsum in comparison to a version of ASTM D4442² modified for use on gypsum. All tests were conducted at NTA Testing Laboratories facility in Nappanee, Indiana.

2. TEST PROGRAM

2.1. DESCRIPTION OF TEST SPECIMENS

48-in x 90-in Vinyl covered 5/16-in National gypsum panels were obtained from Adorn on September 20, 2007. 24-in x 24-in test specimens were cut from the center of these panels for testing.

Table 1: Materials

Material	5/16-in x 24-in x 24-in National Gypsum covered in vinyl by Adorn
Pin Type Test HHMM	Delmhorst BD 2100, conductance moisture meter
Surface Type HHMM	Delmhorst Accuscan, dielectric moisture meter

2.2. TEST PROCEDURE

This test is conducted in accordance with NTA 07-11¹. Accordingly, 24-in x 24-in gypsum specimens are placed in an environmental chamber set to 90°F and 90% RH. Specimens stay in the chamber until they reach equilibrium moisture content. Equilibrium moisture content is determined by using a pin type HHMM periodically. If the moisture content reading has not changed more than 1% over a 24 hour period, the panels are considered at equilibrium. When the specimens have reached equilibrium, moisture content is recorded using both types of meters at all four corners and at the center of the panel. The specimen is weighed and placed in a drying oven. The drying procedure is based on ASTM D4442² with the exception of the oven temperature is maintained at 60°C for gypsum panels. ASTM D2216³ Section 1.4 states that materials containing gypsum have significant amounts of hydrated water. ASTM D2216³ recommends drying gypsum at 60°C to only evaporate the free water without significant loss of hydrated water. The drying procedure is complete when equilibrium mass has been reached.

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Reviewed & Approved By: Douglas Berger

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3. TEST RESULTS

Two 5/16-in x 24-in x 24-in vinyl covered gypsum panels were tested by two types of hand held moisture meters and by drying in accordance with ASTM D4442² modified as stated in this report. The results of each method of measuring moisture content are contained in table 2 below, and in the appendix. The HHMM results were direct readings from the meters. Moisture content using ASTM D4442² is calculated using the following equation:

$$MC\% = 100 \cdot (A - B) / B$$

Where:

MC% = Moisture Content of the test specimen

A = Initial (humidified panel) Mass

B = Final (dried panel) Mass

Table 2: Test Results

Specimen	Delmhorst BD2100 moisture content reading	Delmhorst Accuscan moisture content reading	Modified ASTM D4442² measured free moisture content
13065	1.2%	31.8%	1.9%
13067	1.0%	30.2%	1.9%



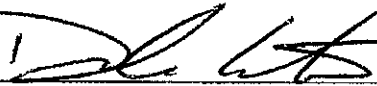
5. CONCLUSION

Ritchey and Simpson, PLLC retained NTA Testing Laboratories, Inc. to evaluate the accuracy of various types of HHMMs when used on vinyl covered 5/16-in gypsum in comparison to a version of ASTM D4442² modified for use on gypsum.

Table 2: Result Summary


Meter Type	Difference in Moisture Content (%) from ASTM D4442 ² Method
Delmhorst BD2100, Pin Type, Conductance Moisture Meter	.8%
Delmhorst Accuscan, Surface Type, Dielectric Moisture Meter	29.1%

PREPARED BY:


Dale Arter,
Director of Testing

12-26-07

REPORT REVIEWED BY:


Douglas Berger, P.E.
Test Engineer

12-26-07

SE120707-26

Prepared By: Dale Arter
Reviewed & Approved By: Douglas Berger

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Issued/Revised: 12/11/07



REFERENCES

1. NTA Testing Laboratories, Inc. *Gypsum Moisture Content Comparison* NTA 07-11 NTA, Nappanee, IN 2007. 4 pp.
2. American Society for Testing and Materials (ASTM). *Standard Test Method for Direct Moisture Content Measurement of Wood and Wood-Base Materials* ASTM D4442-92. ASTM, West Conshohocken, PA, 2003. 6 pp.
3. American Society for Testing and Materials (ASTM). *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.* ASTM D2216-05. ASTM, West Conshohocken, PA, 2005. 7 pp.
4. American Society for Testing and Materials (ASTM). *Standard Test Method for Use and Calibration of Hand Held Moisture Meters* ASTM D4444-92 (2003). ASTM, West Conshohocken, PA, 2003. 6 pp.

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Prepared By: Dale Arter
Reviewed & Approved By: Douglas Berger

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FIGURES

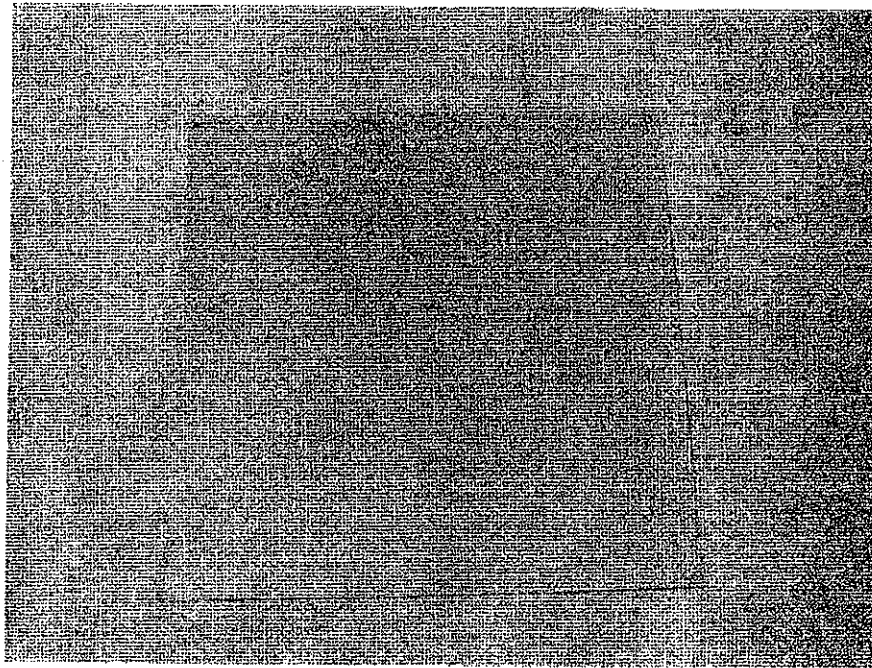


Figure 1: Specimen 13067



Figure 2: Pin Type Moisture Meter

FIGURES

NIA

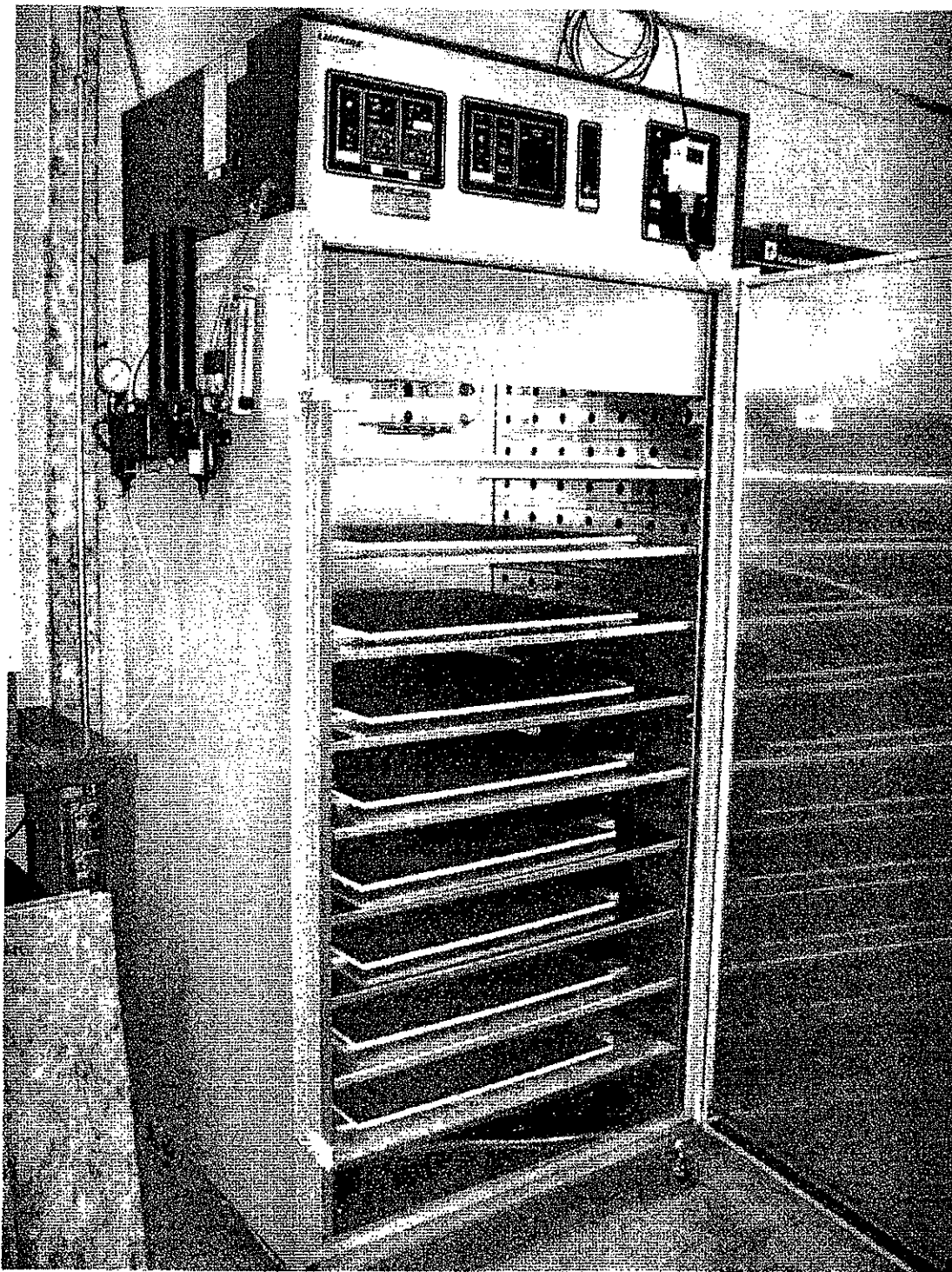


Figure 3: Specimens in Conditioning Chamber

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Issued/Revised: 12/11/07



APPENDIX

SE092407-28 Inclusive
Out

NTA Testing Laboratories, Inc.

NTA 07-11
Gypsum Moisture Content Comparison Testing
Summary Out

General:

Client: Ritchey and Simpson
Job Number: SE120707-26
Performed By: Dale Arter
Test Location: NTA Testing Laboratories, Inc.

Specimen Description:

Manufacturer: National Gypsum
Trade Name/Designation: Vinyl Covered Gypsum
Material Description: 5/16-in. Vinyl covered gypsum adhered by Adom
Nominal Size: 24-in. wide x 24-in. long
Nominal Thickness: 5/16
Date Received: 9/20/2007
Parent No.: 13049

Conditioning:

Temp: 90 \pm 2°F
RH: 90 \pm 2% RH

Apparatus:

Humidity Chamber: 00765
Sensor: 00623
Pin Type HHMM: 00881
Surface Type HHMM: 00882

Specimen	Conditioning Start		Conditioning End	Average Post Conditioning Moisture Content	
	Date/Time	Pin Meter	Date/Time	Pin Meter	Surface Meter
13065	9/22/2007 11:38	0.20	10/3/2007 12:36	1.2	31.8
13067	9/22/2007 11:35	0.22	10/3/2007 12:31	1.0	30.2

Drying Procedure (modified ASTM D4442):

Start Date: 10/3/2007
Start Time: 3:11:00 PM
End Date: 10/5/2007
End Time: 5:52:00 PM

Apparatus:

Convection Oven: 00009
Oven Logger: 00394
Balance: 00003

Drying Temp: 60 deg C

Specimen	Initial Weight	Final Weight	Percent Moisture
13065	2287.42	2243.78	1.9%
13067	2293.79	2250.67	1.9%

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Reviewed/Approved By: Dale Arter

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Issued/Revised: 04/01/05

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Issued/Revised: 12/11/07